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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/628,318	07/28/2003	Jeanette E. O'Hara	GMC 0047 PA/40320.52	4444

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EXAMINER	
CHUO, TONY SHENG HSIANG	
ART UNIT	**PAPER NUMBER**
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/628,318	O'HARA ET AL.	
	Examiner	Art Unit	
	Tony Chuo	1745	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *30 April 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-15,17-27 and 29-45* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *42-45* is/are allowed.

6)☒ Claim(s) *1-15,17-27 and 29-41* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *28 July 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

1. Applicant's arguments, see Pre-Appeal Brief, filed 4/30/07, with respect to the rejection(s) of claim(s) 1-15, 17-27, and 29-41 under 35 USC 103 have been fully considered. The examiner agrees that there is no teaching in Isono that the gas diffusion layer is compressed when being placed in the stack structure. Therefore, the rejections have been withdrawn. However, upon further consideration, new grounds of rejection are made in view of Zuber et al (US 2002/0051901). The examiner disagrees that by reducing the entire thickness of the gas diffusion layer, the compressed Isono gas diffusion layer 122 would have the same thickness along its length. The examiner would like to point out that the compressed gas diffusion layer would only have a reduced thickness in regions that are contacted by the separator plate. Therefore, the remaining regions that are not contacted by the separator plate would have an increased thickness.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1-15, 17-22, 29-31, 33, and 38-39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Isono et al (US 6365293) in view of Yasumoto et al (US

2003/0198860), and further in view of Zuber et al (US 2002/0051901). Regarding claims 1, 9 and 31, the Isono reference teaches a device: fuel cell "100", comprising an electrochemical conversion assembly: anode "120", cathode "110" and solid polymer membrane "101", a first reactant input "fuel gas" and first product output "fuel gas" in communication with first flow field region: fuel gas channels "141", a first porous diffusion media: gas diffusion layer "122", a second reactant input "air" and second product output "air" in communication with second flow field region: oxidizer gas channels "131", a second porous diffusion media: gas diffusion layer "112", a region of high water concentration "115B", a region of low water concentration "115A", a mesoporous layer: mixture layer "113" or "123" comprising a hydrophilic carbonaceous component: carbon black and a hydrophobic component: PTFE, a mesoporous layer occupying a greater portion of one of high water region and low water region relative to other of high water region and low water region; and a mesoporous layer that is carried along a reduced thickness portion of the gas diffusion layer (See Figure 6, column 6, lines 18-20, and column 12, lines 10-12). Regarding claim 2, the Isono reference teaches a ratio of the area of the water permeation suppressing part "24A" to the entire area of the gas diffusion layer "24" within 10 to 90%. The area of the water permeation part "24B" would also be 10-90%. In this case, the area of the water permeation suppressing part is the low water region and the area of the water permeation part is the high water region. Therefore, the mesoporous layer or mixture layer would be confined to one of high water region and low water region (See column 6, lines 18-20). Regarding claims 3-5, the Isono reference teaches a mixture layer with higher water

permeability at the high water region "24B" to enhance the water transfer properties of the gas diffusion layer along the portion of the major face occupied by the mixture layer (See Figure 3 and column 5, lines 30-37). Regarding claims 6-8, the Isono reference teaches a mixture layer with lower water permeability at the low water region "24A" to diminish water transfer properties of the gas diffusion layer along the portion of the major face occupied by the mixture layer (See Figure 3 and column 5, lines 30-37). Regarding claims 10 and 12, the Isono reference teaches a layer "115" comprising a gas diffusion layer "112" and mixture layer "113" where the water permeability is relatively low in an area closer to the entrance of the oxidizer gas and the water permeability is relatively high in an area closer to the exit of the oxidizer gas. The region of low water concentration is the area closer to the entrance of the oxidizer gas and region of high water concentration is the area closer to the exit of the oxidizer gas. The second reactant input is the area closer to the entrance of the oxidizer gas and the second product output is the area closer to the exit of the oxidizer gas on the cathode side of the fuel cell. The mixture layer also occupies a greater portion of the high water region near the second product output (See column 10, lines 41-46). Regarding claim 11, the Isono reference teaches a mixture layer that is configured to enhance H_2O transfer properties of at least one of first and second gas diffusion layer along portion of major face occupied by the mixture layer; a region subject to relatively high H_2O concentration that is proximate first reactant input in communication with anode side of device; and mixture layer that occupies a substantially greater portion of high H_2O region proximate first reactant input. Examiner's note: The region subject to relatively

high H_2O concentration that is proximate first reactant input can also be interpreted as a region proximate to first product output, second reactant input, or second product output due to lack of spatial orientation of the components of the fuel cell. Regarding claim 13, the Isono reference teaches a mixture layer that is configured to diminish H_2O transfer properties of at least one of gas diffusion layers along portion of major face occupied by mixture layer; a region subject to relative low H_2O concentrations that is proximate first product output in communication with anode side of device; and a mixture layer that occupies a substantially greater portion of low H_2O region proximate first product output. Examiner's note: The region subject to relatively low H_2O concentration that is proximate first product output can also be interpreted as a region proximate to first reactant input, second reactant input, or second product output due to lack of spatial orientation of the components of the fuel cell. Regarding claims 14 and 15, the Isono reference teaches two mixture layers "211" and "212" along a major face of one of the first and second gas diffusion layers. The mixture layer "212" that is configured to enhance water transfer properties of gas diffusion layer occupies a greater portion of the high water region at the exit of the oxidizer gas. The mixture layer "211" that is configured to diminish water transfer properties of gas diffusion layer occupies a greater portion of the lower water region at the entrance of the oxidizer gas. (See Figures 12A and 12B). Regarding claim 17, the Isono reference teaches a reduced thickness portion of the substrate that is sufficient to accommodate for an increase in diffusion media thickness introduced by the mixture layer. Examiner's note: The diffusion media substrate is interpreted as being a reduced thickness along it's entire length. Therefore

any additional thickness introduced by the mixture layer will result in an increase in the thickness of the diffusion media. Regarding claim 18, the Isono reference teaches a gas diffusion layer that comprises carbon paper which is a carbonaceous fibrous matrix (See column 6, lines 60-61). Regarding claim 19, the Isono reference teaches a mixture layer where the hydrophobic component comprises PTFE which is a fluorinated polymer (See column 12, lines 10-12). Regarding claim 20, the Isono reference teaches a mixture layer where the hydrophilic carbonaceous component comprises carbon black powder (See column 12, lines 10-12). Regarding claim 21, the Isono reference teaches a carbon black characterized by a surface area of 200-300 m^2/g (See column 12, lines 35-36). Regarding claim 22, the Isono reference teaches a carbon black characterized by a surface area of 700-800 m^2/g (See column 12, lines 10-11). In addition, it is inherent that a higher surface area carbon black would have a smaller mean particle size. Regarding claims 29 and 30, the Isono reference teaches a mixture layer that infiltrates at least one of the first and second diffusion media substrates to a depth of less than 10μm in the high H_2O region and to a depth of less than 25 μm in the low H_2O region. Examiner's note: The limitation of less than 10μm and less than 25 μm can be interpreted as being zero. Regarding claim 33, the Isono reference teaches the ratio of pores of the gas diffusion layer that is small, i.e. low porosity, at the entrance part which is the low water region and the ratio of pores of the gas diffusion layer that is large, i.e. high porosity, at the exit part which is the high water region (See column 2, lines 11-17). Regarding claim 38 and 39, the Isono reference teaches a gas diffusion layer that is 200 μm in thickness which is between 100 μm and 300 μm in the high water

regions and between 190 μm and 300 μm in the low water regions (See column 6, line 61).

However, the reference does not expressly teach a moderate surface area carbon characterized by mean particle size of between about 15 nm and about 70 nm. The Yasumoto reference does teach a carbon black for a gas diffusion layer of a fuel cell that has a particle size of 35 nm (See paragraph [0141]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the Isono fuel cell to include a carbon black that has a particle size of 35 nm because it is commonly used in the production of gas diffusion layer for fuel cells.

However, Isono et al as modified by Yasumoto et al does not expressly teach at least one of the first and second diffusion media substrate that comprises an increased thickness portion and a reduced thickness portion. The Zuber reference discloses compression of the gas distribution layers "8" & "9" by the bipolar plates "3" & "4" to 30 to 50% of their original thickness (See paragraph [0015]). Examiner's note: It is inherent that the compression of the gas distribution layers by the bipolar plates would result in regions where the convex parts of the bipolar plate contact the gas distribution layer such that the thickness of the gas distribution layer is reduced in that region. Therefore, the remaining regions that are not contacted by the bipolar plate would have an increased thickness.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the Isono/Yasumoto fuel cell by compressing the

gas distribution layer such that the gas distribution layer has an increased thickness portion and a reduced thickness portion in order to reduce the specific resistance of the gas distribution layer and prevent flooding of the pores with reaction water which results in a decisive improvement in the electrical output of the fuel cell stack.

4. Claims 23-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Isono et al (US 6365293) in view of Yasumoto et al (US 2003/0198860) and Zuber et al (US 2002/0051901) as applied to claims 1-15, 17-22, 29-31, 33, and 38-39 above and further in view of Fuglevand et al (US 6939636). However, the references do not expressly teach a mesoporous layer comprising about 80 wt% or between 75 and 85 wt% of carbonaceous component in the high water region. The Fuglevand reference does teach a mesoporous layer: micro-diffusion layer that has about 80% carbon content and 20% PTFE (See column 7, lines 35-36). Therefore, it would be obvious to one of ordinary skill in the art at the time the invention was made to modify the mesoporous layer of the Isono fuel cell to include about 80% carbon content in order to increase the porosity of the mesoporous layer at the high water region.

5. Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over Isono et al (US 6365293) in view of Yasumoto et al (US 2003/0198860) and Zuber et al (US 2002/0051901) as applied to claims 1-15, 17-22, 29-31, 33, and 38-39 above and further in view of Fuglevand et al (US 6939636). However, the references do not expressly teach a mesoporous layer comprising between about 90 and 95 wt% of carbonaceous component in the low water region. The Fuglevand reference does teach a mesoporous layer: micro-diffusion layer that has about 90% carbon content and 10%

PTFE (See column 7, lines 47-48). Therefore, it would be obvious to one of ordinary skill in the art at the time the invention was made to modify the mesoporous layer of the Isono fuel cell to include about 90% carbon content in order to decrease the porosity of the mesoporous layer at the low water region.

6. Claims 26 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Isono et al (US 6365293) in view of Yasumoto et al (US 2003/0198860) and Zuber et al (US 2002/0051901) as applied to claims 1-15, 17-22, 29-31, 33, and 38-39 above and further in view of Zuber et al (US 2002/0041992). However, the references do not expressly teach a mesoporous layer that defines a thickness of less than 20 μm in the high H_2O region or a mesoporous layer that defines a thickness of between about 10 μm and about 40 μm in the low H_2O region. The Zuber reference teaches a hydrophobic layer containing PTFE that is located on a diffusion media substrate wherein the thickness of this layer is between 12 to 15 μm (See paragraph [0060]). Examiner's note: The Zuber reference is relevant because it discloses a similar porous layer comprising a hydrophobic component that performs the same as the applicant's mesoporous layer of varying the water permeability of the gas diffusion structure. Therefore, it would be obvious to one of ordinary skill in the art at the time the invention was made to modify the Isono/Yasumoto/Zuber fuel cell to include a mesoporous layer that defines a thickness of less than 20 μm in the high H_2O region and between about 10 μm and about 40 μm in the low H_2O region in order to ensure optimum proton conductivity of the electrolyte by maintaining proper humidity and avoiding flooding of the pores of the anode and cathode.

7. Claim 32 is rejected under 35 U.S.C. 103(a) as being unpatentable over Isono et al (US 6365293) in view of Yasumoto et al (US 2003/0198860) and Zuber et al (US 2002/0051901) as applied to claims 1-15, 17-22, 29-31, 33, and 38-39 above and further in view of Wood, III et al (US 6350539). However, the references do not expressly teach a structure defining a vehicle powered by the fuel cell. The Wood reference does teach a fuel cell that produces power for vehicle propulsion (See column 1, lines 5-9). Therefore, it would be obvious to one of ordinary skill in the art at the time the invention was made to modify the Isono/Yasumoto/Zuber fuel cell for producing power for a vehicle so that it can be used in a practical application.

8. Claims 34-37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Isono et al (US 6365293) in view of Yasumoto et al (US 2003/0198860) and Zuber et al (US 2002/0051901) as applied to claims 1-15, 17-22, 29-31, 33, and 38-39 above and further in view of Johnson et al (US 5840438). However, the references do not expressly teach a gas diffusion layer with a porosity of up to 90% in the high porosity region, a porosity of between 70% and 75% in the low porosity region, a porosity of above about 70% in the high water region, and a porosity of between 70% and 75% in the low water region. The Johnson reference teaches that a typical gas diffusion layer is made of a carbon fiber paper with a porosity of approximately 70% that would be used in the high porosity region, low porosity region, high water region, and low water region (See column 1, lines 22-28). Therefore, it would be obvious to one of ordinary skill in the art at the time the invention was made to modify the gas diffusion layer of the

Isono fuel cell to include a carbon paper with a porosity of about 70% because it's a readily available material.

9. Claims 40 and 41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Isono et al (US 6365293) in view of Yasumoto et al (US 2003/0198860) and Zuber et al (US 2002/0051901) as applied to claims 1-15, 17-22, 29-31, 33, and 38-39 above and further in view of Mussell et al (US 5620807). However, the references do not expressly teach a gas diffusion layer with a mean pore size of above about 20 μm in the high water region and less than about 25 μm in the low water regions. The Mussell reference does teach a gas diffusion layer with two regions of different mean pore sizes: 0.1-10 μm in small pore region and 30 μm in the large pore region (See Figure 1, column 5, lines 41-44, column 6, lines 1-2). Therefore, it would be obvious to one of ordinary skill in the art at the time the invention was made to modify the gas diffusion layer of the Isono/Yasumoto/Zuber fuel cell to include a mean pore size of above about 20 μm in the high water region and less than about 25 μm in the low water regions in order to increase the porosity of the high water region and decrease the porosity of the low water region.

Allowable Subject Matter

10. Claims 42-45 are allowed. Regarding claims 42 and 43, the Isono reference discloses a mixture layer that is carried along at least a portion of a major face of one of the first and second gas diffusion layers and comprises a hydrophilic carbonaceous component and a hydrophobic component. However, Isono et al does not expressly

teach a mesoporous layer comprising a region of increased porosity relative to a remaining portion of the mesoporous layer wherein the region of increased porosity of the mesoporous layer occupies a substantially greater portion of the high water region relative to the low water region.

Regarding claims 44 and 45, Isono et al does not expressly teach a mesoporous layer at least partially infiltrates at least one of the first and second diffusion media substrates to a depth of greater than 0 microns to about 10 microns in the high water regions and a depth of greater than 0 microns to about 25 microns in the low water regions.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tony Chuo whose telephone number is (571) 272-0717. The examiner can normally be reached on M-F, 8:30AM to 5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on (571) 272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should

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TC

JONATHAN CREPEAU
PRIMARY EXAMINER